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(56) Documents cited
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US 4514850 A US 3660779 A US 3628178 A
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UK CL (Edition J) H1C CBAA CBAX CBBA CBBB CBBC CBBD CBBE CBC CBX CCA CCB CCD CCX CEC CGA CS
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(54) **Conical mirror laser resonator**

(57) A laser resonator has a conical mirror with a nominal inclusive angle of 90 degrees. Two conical mirrors may be used, one as the end reflector and the other as the output coupler. The conical resonator may be used in an oscillator/amplifier system (Fig 2).

A circularly polarised beam is produced as required for multi-directional processing (eg cutting/drilling).

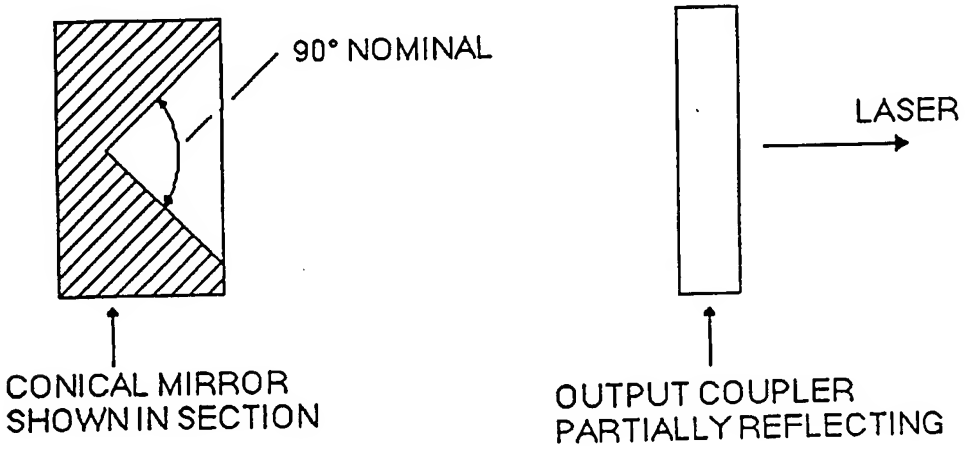

FIGURE 1

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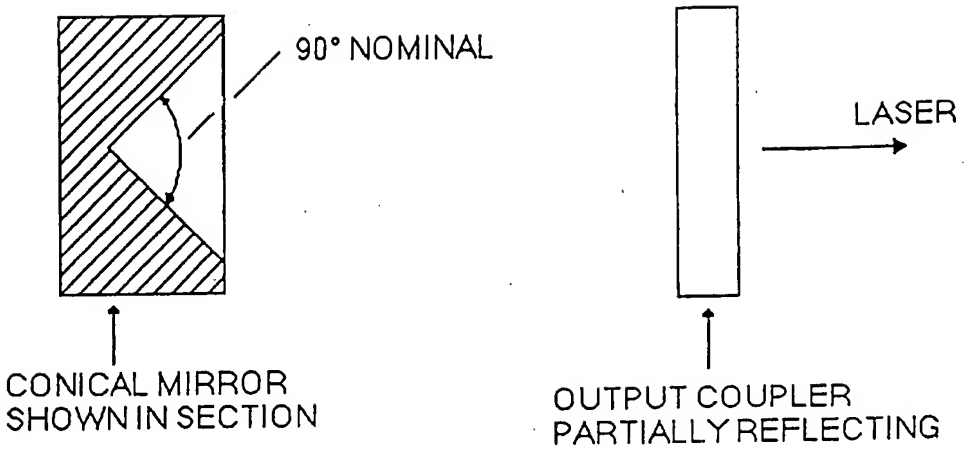
90° NOMINAL
LASER
CONICAL MIRROR
SHOWN IN SECTION
OUTPUT COUPLER
PARTIALLY REFLECTING

FIGURE 1

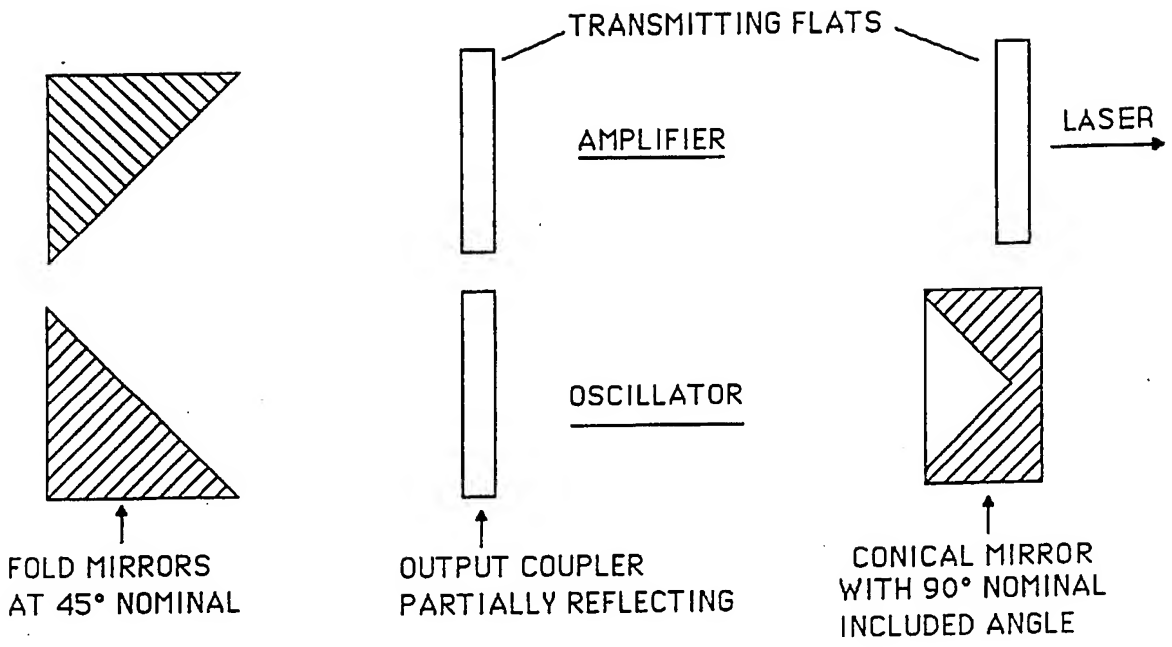
TRANSMITTING FLATS
AMPLIFIER
LASER
OSCILLATOR
FOLD MIRRORS
AT 45° NOMINAL
OUTPUT COUPLER
PARTIALLY REFLECTING
CONICAL MIRROR
WITH 90° NOMINAL
INCLUDED ANGLE

FIGURE 2

CONICAL MIRROR RESONATOR

DESCRIPTION

The invention is concerned with a laser resonator configuration having a conical mirror end reflector. The nominal inclusive angle of the mirror cone is ninety degrees as shown in Figure 1. The resonator will be referred to as the conical resonator.

The purpose of the invention is to improve certain qualities of the laser beam in order to obtain an advantageous effect related to processing of materials.

It is known that the state of polarisation of the laser beam is of relevance to cutting, scribing and drilling. A laser beam produced from a folded cavity will be plane polarised because of the enhanced 'S' reflectance. As a result optimum processing can only be carried out in a certain direction. Consistent multi-directional processing requires a circularly polarised beam which is achieved using an additional optical element. A plane polarised beam when used for drilling produces a distorted hole shape rather than the circular hole that is required. The state of polarisation of a laser beam produced by a straight-spherical or plane-parallel resonator will be random. As a result consistent results are not obtained in processing materials.

The laser beam produced by the conical resonator has produced results in cutting and drilling to indicate that at a given time, the beam is equally polarised in all directions.

Compared to straight and folded resonators with plane or hemispherical mirrors, cutting at faster speeds in a non-directional manner is possible using the beam from the conical resonator. Further, holes drilled using the conical resonator beam are circular compared to distorted shapes produced by the plane polarised beams.

A further aspect is that the conical resonator is less sensitive to mirror misalignment compared to non-confocal straight and folded resonators with plane or hemispherical mirrors. From geometrical optics, it can be shown that the deviation of a ray after two reflections from two mirrors inclined to each other at an angle 'α' is independent of the angle of incidence and is given by $2 (\pi - \alpha)$ if the plane of incidence is perpendicular to the line of inter-section of the two mirrors. This is also valid for the conical mirror; therefore, the conical resonator will be less sensitive to mirror misalignment because the mode axis is not displaced.

A another observed aspect is the 'doughnut' structure and the good symmetry of the intensity distribution of the beam from the conical resonator. The 'doughnut' structure is particularly useful in surface modification processes because the less centralised intensity of the beam. Ray reversal has the result that mode quality of the conical resonator is less susceptible to degradation by optical and gain inhomogeneities of the medium.

The power produced by the conical resonator is comparable to the power produced by a straight resonator with a hemispherical mirror, under the same conditions.

A further embodiment of the conical mirror resonator is shown in Figure 2.

Claims

Conical Mirror Resonator

1. A laser resonator configuration having conical mirrors with a nominal inclusive angle of 90 degrees as its reflectors.

2. A laser resonator, according to claim 1, in which the conical mirror is the end reflector.

3. A laser resonator, according to claim 1, in which the conical mirror is the partially reflecting output coupler.

4. A laser resonator, according to claim 1, in which the conical mirrors are the output coupler and the end reflector.

5. A laser resonator, according to any one of claims 1 to 4, which is an oscillator in an oscillator/amplifier system.

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